

Aerosol and Gas Emissions: Dissecting Future Aerosol Emissions

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This paper presents an overview of global emissions of all major species involved in the formation of radiatively active species in the atmosphere, as well as those implicated in local air pollution and the direct health effects caused by it. The paper compares and contrasts the contributions of different world regions and emitting sectors. The underlying reasons for the remarkable variations in emissions distributions can be understood partly by reference to the patterns of fuel use and human activity around the world, but also by the use of technologies having different emission rates. As we survey the levels of economic development around the world, we see an array of technologies ranging from the very primitive (open fires used for cooking) to the very sophisticated (electric stoves powered by nuclear energy) that heavily influence emission patterns.

In order to understand the current patterns of emissions and to be able to predict future emissions and design effective control measures, we need to be able to characterize technologies and fuels around the world in a rather detailed manner. It is not sufficient to simply target particular forms of energy usage or particular technologies for control in certain sectors. The reasons are that emissions of each species are tightly linked and that human and economic activities are entwined with environmental progress in complex ways. Substitution of one form of energy use by another in a particular part of the world can fundamentally alter the mix of species emitted to the atmosphere. To put it another way: it's not a simple question of "Soot and Sulfate: Can reduced soot emissions counteract the warming effects of reducing sulfates?" (topic of one workshop session). Any action that we take will influence emissions of *both* species in ways that are not easy to predict—as well as many other species. So we need to be able to understand the interrelationships between emissions of gaseous and particle emissions from the perspectives of both future global developments and specific actions that can be taken.

We can begin to do this by analyzing the results of model forecasts of future emissions and dissecting them by their various contributions. Using new projections of emissions of black carbon (BC) and organic carbon (OC) [Streets *et al.*, *JGR*, 109, D24212, 2004] and IPCC sulfur dioxide (SO₂) emission forecasts, we can begin to understand the interrelationships of the primary species involved in aerosol formation. For example, Figure 1 is a scatter plot of emission reductions of BC and OC for the transportation sector, for 17 world regions, two future years (2030 and 2050), and four IPCC SRES (A1B, A2, B1, and B2). We can see that in the developed world, particularly Europe and North America (linear points in upper right quadrant), emission reductions of both species are expected, in accordance with the tightening of vehicle particulate standards. In contrast, high economic growth scenarios in the near term (2030 A1B) lead to increases in emissions of both species throughout the developing world. There are even cases in which OC emissions are reduced while BC emissions increase.

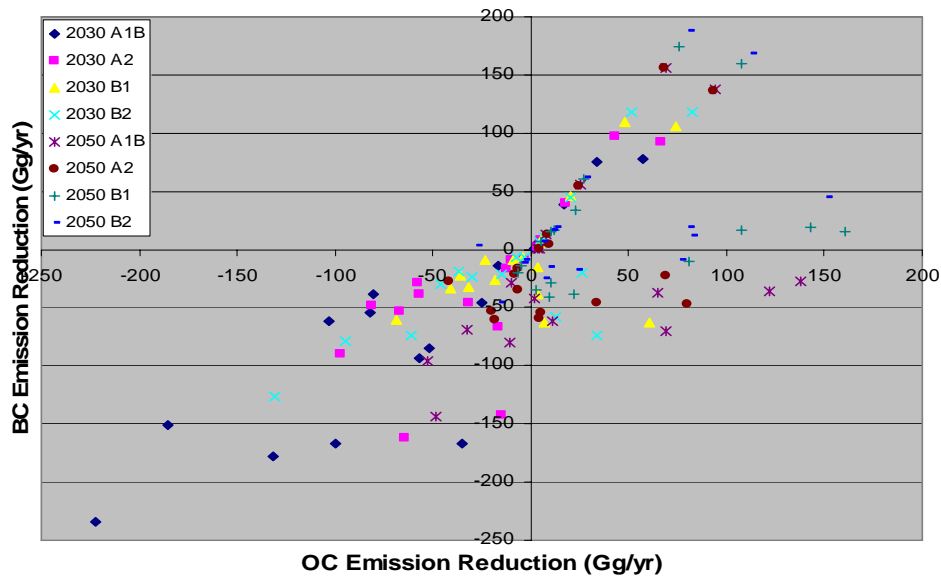


Figure 1 Scatter plot of scenario endpoints for global transportation emission reductions of BC and OC

When we examine the relationship between total SO_2 (as surrogate for SO_4) and BC emissions over the same range of scenarios and world regions (Figure 2), we are struck by the importance of emissions from East Asia in determining BC emission reductions, which actually span a range of increased and decreased SO_2 emission possibilities. We also see that the strong economic growth scenarios (A1B and A2) coupled with low technology transfer yield endpoints of both increased BC and SO_2 . Fortunately, few endpoints yield warm/warm combinations of reduced SO_2 and increased BC. Such analyses can guide the design of effective control measures in different sectors and world regions to optimize environmental gains. The presentations by Tami Bond and Dorothy Koch will examine these emissions data from different, but related perspectives.

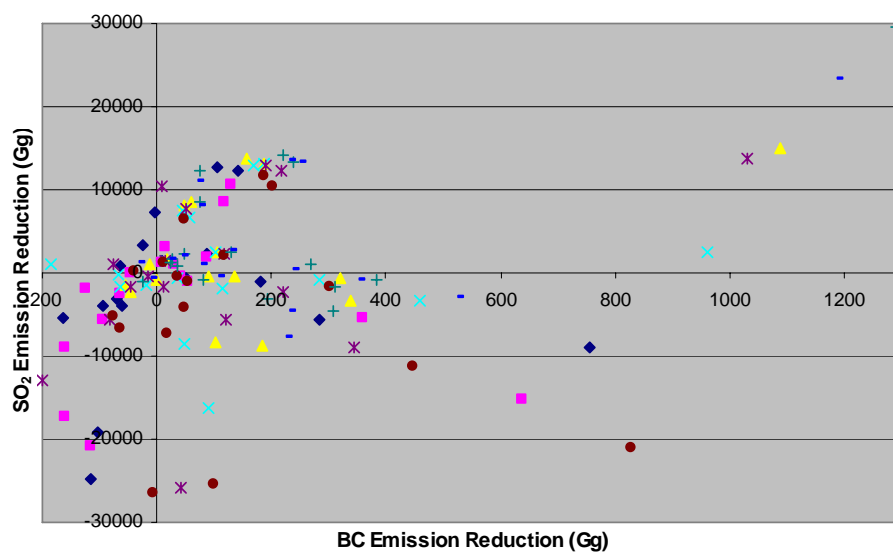


Figure 2 Scatter plot of scenario endpoints for emission reductions of SO_2 and BC